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BROAD-NOSED GRAIN WEEVIL.

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INTRODUCTION.

The broad-nosed grain weevil, *Caulophilus latinasus* Say, has received but little attention from economic entomologists, and practically nothing has been published on the biology of this insect. It is now widespread over Florida and has been reported from Georgia and South Carolina. It is not unlikely that it will gradually spread to other parts of the South and add to the already heavy damage caused by the rice weevil, *Sitophilus oryza* Linn.

The damage caused by the broad-nosed grain weevil is more than has been generally supposed. While more often found infesting stored corn and chick peas, it commonly attacks a variety of seeds and cereals. Infested seeds are quickly reduced to a powdery mass by the combined efforts of the grubs and adult weevils.

It is interesting to note that whole grain or seed of a medium degree of hardness is entirely immune from the attack of this weevil. The writer has many times confined weevils with whole grain and chick peas, with the result that invariably the weevils died from starvation without being able to penetrate the grain.

The broad-nosed grain weevil, however, is often associated with the common rice weevil, *Sitophilus oryza*, and the attack of the common rice weevil makes it a simple matter for its weaker associate to reach the softer portions of the grain. Cracked, damaged, or soft seed is quickly infested by the broad-nosed grain weevil.

The following notes on the life history and habits of this weevil were made at Orlando, Fla., during 1919, 1920, and a part of 1921.

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ORIGIN AND ECONOMIC HISTORY.

Caulophilus latinasus was described in the year 1831 by Thomas Say (*13: 1831, p. 30; 1859, p. 299*)[1] from specimens taken in Florida It is thought to be native to the American continent and is not as yet very widely distributed.

In 1878 Schwarz (*14, p. 468*) recorded it from Florida as "rare, beaten from dead twigs." Ten years later Riley and Howard (*11, p. 198*) stated that the genus lived under the bark of dead and decaying wood or bored into decaying wood of deciduous or coniferous trees. In 1894 Townsend[2] reported it as occurring in a can of ginger. Two years later Chittenden (*3, p. 29–30*) reported it for the first time as attacking stored grain, having found it in a shipment of corn and chick peas obtained from the Mexican exhibit at the Atlanta Exposition. In 1897 (*4, p. 30–31*) and 1911 (*5*) Chittenden published short accounts concerning the occurrence of this weevil in the United States, its synonymy, its reported distribution, the damage caused by it, etc., and also included a list of references to this species in literature.

Since then it has been reported by the following writers as attacking seeds of the avocado in Florida: Schwarz (*1, p. 183*), Sasscer (*12, p. 4–5*), Blatchley and Leng (*2, p. 535*), Pierce (*8, p. 30, pl. 49*), Popenoe (*9, p. 6*) (*10, p. 34–35, pl. 40*), Hoyt (*6*), and Moznette (*7*). It was also found by inspectors of the Federal Horticultural Board infesting roots of dasheen in storage at Brooksville, Fla.

PRESENT KNOWN DISTRIBUTION.

Caulophilus latinasus is now widespread over Florida and has been reported from South Carolina and Georgia. So far as can be determined, it has not become permanently established in either of the two latter States. It is abundant within a few miles of the boundary between Florida and Georgia, however, and may be expected to invade the southern portion of Georgia.

It is known to occur in Jamaica, Cuba, Porto Rico, Mexico, Guatemala, and Madeira, and is doubtless common throughout the islands of the West Indies and in the countries of Central and South America.

FOOD.

Caulophilus latinasus is known to breed in corn, chick peas, millets, acorns, and seed of the avocado and has occasionally been found breeding in the roots of the dasheen and in sweet potatoes.

In addition, the adult weevils feed readily on wheat, barley, wheat flour, ginger, and macaroni. The writer has occasionally found them feeding on fresh fruits, and E. R. Sasscer, of the Federal Horticultural Board, states that the board has observed injury to chayotes by this weevil.

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[1] Reference is made by number (italic) to "Literature cited," p. 10.

[2] TOWNSEND, C. H. T. Institute of Jamaica, Notes from the Museum, No. 78, 1894. (Hectographed.)

LIFE HISTORY (Pl. I).[3]

The adults of the broad-nosed grain weevil possess functional wings, and although not great fliers they are capable of making short flights in search of food. They fly to the cornfields in the summer, feed on the grain, and deposit eggs in it before it becomes fully hardened.

The damaged and exposed ears of corn are the ones that are attacked by the weevils, those ears that have a well-developed and tightly fitting shuck being entirely immune from attack.

After the grain is harvested and placed in storage the work of destruction continues. The kernels infested in the field are completely destroyed, and the multiplying weevils attack cracked and broken kernels and grain that is softened by excess moisture or is damaged by the depredations of other grain pests.

OVIPOSITION.

Under favorable conditions oviposition occurs more frequently during the hours of the morning; eggs are laid, however, at all times of the day.

The female weevil excavates the egg cavity in a manner very similar to that of *Sitophilus oryza*. The weevil places herself in the desired position. The sharp hook or claw on the end of the tibia of each leg is dug into the surface of the kernel, the four legs thus forming pivots on which the body oscillates. This oscillating movement of the body, together with a turning movement of the head, imparts to the proboscis a combined up-and-down and rotary motion. The position of the legs is not changed, as a rule, until the excavation is completed, and the proboscis or beak is seldom withdrawn during this time. Work on the cavity continues until its depth approximates the length of the beak from the tip to the eyes. The sides are then smoothed off.

After the completion of the cavity the weevil reverses her position and places the tip of her abdomen over the mouth of the egg cavity. After a period of from two to three minutes the egg is ejected from the ovipositor into the cavity, followed by a liquid secretion that forms a cap and cements the egg into place. This secretion quickly hardens. Immediately after the egg is deposited the weevil turns about and tamps down the edges of the egg cap with her beak, picking up small pieces of the borings from the excavation and tamping in around the edges.

The egg cap is transparent, and the outer surface is invariably exactly level with the surrounding surface of the corn. After the young larva has emerged from the egg and the egg cavity is filled with larval borings it is often difficult to detect the original position of the egg.

[3] In breeding experiments from which the life-history data were taken corn was used as the host seed.

WHERE THE EGGS ARE LAID.

In broken or damaged corn the eggs usually are laid either in the germ or in the soft starch of the endosperm, and very rarely in the harder horny part of the kernels. In the case of undamaged kernels eggs are laid only if the corn is very soft, as ordinarily the seed coat is too tough for the weevil to penetrate.

OVIPOSITION PERIOD AND NUMBER OF EGGS LAID.

The preoviposition period of the broad-nosed grain weevil is apparently a little longer than that of the other grain weevils. The shortest period observed was nine days; however, it was not uncommon for a period of from one to two months to elapse after emergence before the first egg was laid.

The oviposition period, once started, extends over most of the remainder of the life of the weevil. The longest oviposition period observed was 176 days; the average was somewhat less, approximately 123 days.

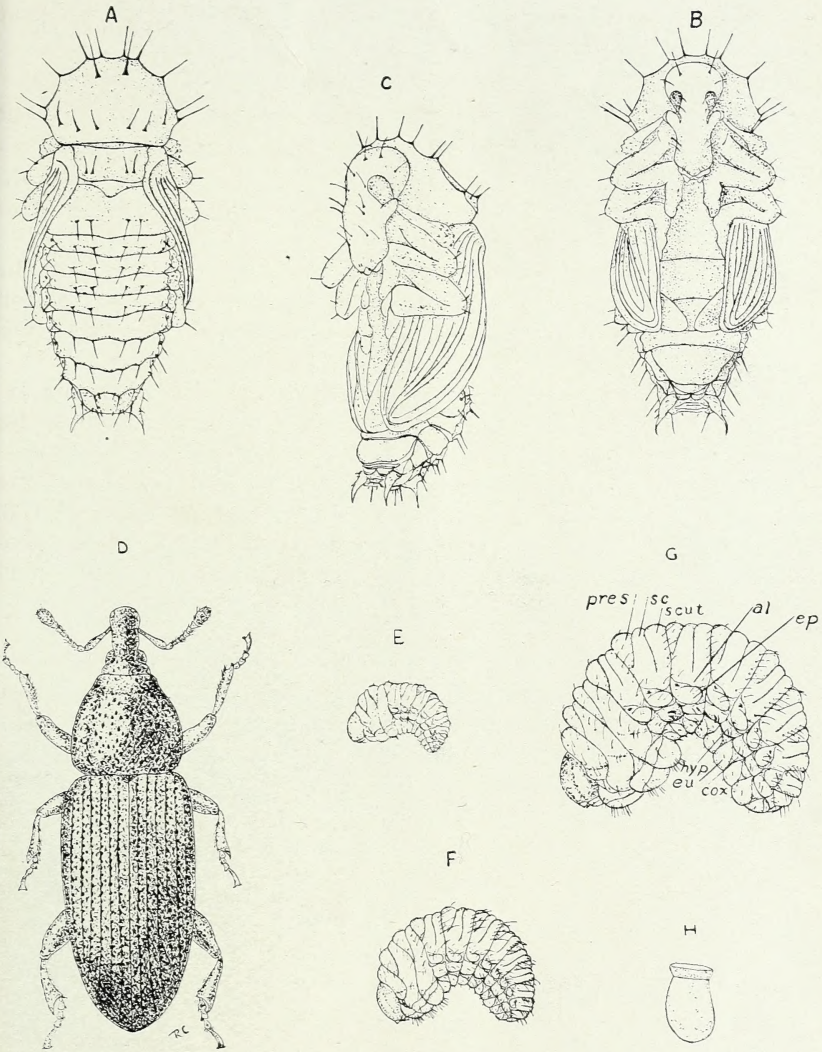
The number of eggs laid by the female of this species is not exceptionally great. The largest number laid by a single female under observation was 229. These were laid over a period of 124 days—August 13, 1919, to December 14, 1919, an average of almost 2 a day. As shown in Table 1, the average number laid is about 136. Table 1 contains data concerning the preoviposition period, the oviposition period, the number of eggs laid, and the length of life of 11 representative individual weevils.

TABLE 1.—*Oviposition data for Caulophilus latinasus.*

Weevil No.	Date weevil emerged.	Length of preoviposition period.	Date first egg was laid.	Date last egg was laid.	Length of oviposition period.	Number of eggs laid.	Date of death.	Length of life.
		Days.			*Days.*			*Days.*
1	June 28, 1919	16	July 14, 1919	Dec. 15, 1919	155	196	Dec. 20, 1919	176
2	do	46	Aug. 13, 1919	Dec. 14, 1919	124	229	Dec. 22, 1919	178
3	Sept. 11, 1919	13	Sept. 24, 1919	Dec. 15, 1919	83	152	do	103
4	Feb. 25, 1920	31	Mar. 27, 1920	Aug. 4, 1920	131	65	Aug. 13, 1920	171
5	May 6, 1920	57	July 2, 1920	Oct. 6, 1920	97	156	Oct. 17, 1920	165
6	Aug. 1, 1920	9	Aug. 10, 1920	Jan. 24, 1921	168	182	Feb. 1, 1921	185
7	do	9	do	Oct. 27, 1920	79	85	Nov. 4, 1920	96
8	Aug. 7, 1920	12	Aug. 19, 1920	Oct. 26, 1920	69	68	Nov. 2, 1920	88
9	do	13	Aug. 20, 1920	Feb. 11, 1921	176	160	Feb. 16, 1921	194
10	Aug. 9, 1920	22	Aug. 31, 1920	Feb. 9, 1921	163	127	do	192
11	Oct. 12, 1920	12	Oct. 24, 1920	Feb. 11, 1921	111	75	Feb. 19, 1921	131
Average		22			123	136		152

RATE OF OVIPOSITION.

Oviposition continues throughout the year in a fairly uniform manner. In the summer months the rate of oviposition averages about two eggs a day, while in winter the rate drops to about one per day. It is not uncommon for three and four eggs to be laid per day during the summer, and in the colder portions of winter oviposition may cease entirely for a day or two. The greatest number laid by one individual in 24 hours was six. This occurred but once. Table 2 contains data concerning the rate of oviposition at various times of the year.



CAULOPHILUS LATINASUS.

A, Pupa, dorsal view; B, pupa, ventral view; C, pupa, lateral view; D, adult; E, first-stage larva; F, second-stage larva; G, mature larva; H, egg.
Key to larval parts: *al*, Alar area; *cox*, coxal lobe; *ep*, epipleurum; *eu*, eusternum; *hyp*, hypopleurum; *pres*, praescutum; *sc*, scutum; *scut*, scutellum.

TABLE 2.—*Rate of oviposition of Caulophilus latinasus.*[1]

Date.	Temperature.			Number of eggs laid by weevil No.—						
	Max.	Min.	Mean.	1	2	3	4	5	6	7
1920.	° F.	° F.	° F.							
Aug. 10	94	70	82	1	1	...	...	...	...	...
12	95	70	82.5	1	0	(2)	...	...	...	...
19	95	69	82	2	1	1	(2)	...	...	...
20	95	69	82	2	1	1	1	...	...	..
26	97	70	83.5	1	1	4	1	...	...	..
27	94	69	81.5	1	2	3	1	...	...	..
Sept. 4	90	69	79.5	1	2	1	1	(3)	...	...
5	92	70	81	2	2	2	2	1	...	...
11	96	72	84	4	1	0	2	1	...	...
12	98	69	83.5	2	2	2	1	2	...	...
17	89	67	78	2	1	1	1	1	...	...
18	92	68	80	3	3	1	1	2	...	...
24	84	70	77	4	2	1	2	0	...	...
25	89	70	79.5	4	2	1	2	2	...	...
Oct. 1	75	46	60.5	2	1	1	1	1	...	...
2	82	48	65	1	2	0	1	0	...	...
8	80	50	65	0	0	1	0	0	...	...
9	84	52	68	0	0	1	0	0	...	...
15	88	62	75	0	0	1	0	0	...	...
16	88	60	74	0	0	1	0	0	(4)	(4)
26	87	64	75.5	2	2	1	2	1	1	1
27	88	66	77	2	2	(5)	2	2	1	1
Nov. 1	84	59	71.5	1	(6)	...	1	0	0	0
2	86	57	71.5	2	...	...	2	0	0	0
7	85	60	72.5	1	...	...	2	0	0	1
8	86	60	73	2	...	...	2	0	0	1
14	78	57	67.5	0	...	...	1	2	0	1
15	75	63	53.5	0	...	...	0	0	0	0
20	81	52	66.5	1	...	...	1	2	0	0
21	83	54	68.5	0	...	...	1	2	1	1
28	76	58	67	0	...	...	1	2	1	1
1920.	° F.	° F.	° F.							
Nov. 29	77	48	62.5	1	...	...	1	1	1	1
Dec. 1	71	58	64.5	1	...	...	3	1	1	1
2	70	41	55.5	0	...	...	0	0	1	0
7	78	59	68.5	1	...	...	2	2	1	1
8	72	58	65	2	...	...	2	2	1	2
13	84	55	69.5	3	...	...	1	3	2	1
14	75	67	71	2	...	...	1	2	2	0
18	70	36	53	0	...	...	0	0	0	0
19	75	37	56	0	...	...	0	0	0	0
26	78	44	61	1	...	...	1	1	1	1
27	84	68	76	1	...	...	1	3	4	2
1921.										
Jan. 1	84	44	64	1	...	...	1	2	2	2
2	79	62	70.5	1	...	...	2	2	1	1
7	74	45	59.5	1	...	...	0	1	0	1
8	79	51	65	0	...	...	0	0	1	0
13	78	48	63	1	...	...	1	1	1	0
14	79	61	70	0	...	...	0	1	1	1
18	79	46	62.5	0	...	...	2	1	0	1
19	73	53	63	1	...	...	0	1	0	1
23	83	50	66.5	1	...	...	1	1	1	1
24	81	49	65	1	...	...	0	1	1	1
Feb. 1	84	50	67	(7)	...	...	0	1	0	0
2	82	44	63	...	...	...	0	0	0	1
7	84	58	71	...	...	...	1	2	1	1
8	84	52	68	...	...	...	1	2	1	2
13	74	38	56	...	...	...	0	0	0	1
14	74	40	57	...	...	...	0	0	0	0
20	.....	.....	.....	...	...	...	(8)	(8)	(9)	2
21	80	52	66	...	...	...	...	...	...	1
	.....	.....	.....	...	...	...	...	...	...	(10)

[1] The mean temperature of the crib in which these records were made is about 3° to 4° F. higher than the outdoor temperature quoted in this table.

[2] Emerged Aug. 7, 1920.
[3] Emerged Aug. 9, 1920.
[4] Emerged Oct. 12, 1920.
[5] Died Nov. 2, 1920.
[6] Died Nov. 4, 1920.
[7] Died Feb. 1, 1920.
[8] Died Feb. 16, 1921.
[9] Died Feb. 19, 1921.
[10] Still alive.

EGG STAGE.

During the summer months, with the temperature ranging from 65° to 99° F., with a mean of 81°, the egg hatches in four days. As the weather gets colder the incubation period gradually lengthens until, in the coldest winter months, with the temperature ranging from 34° to 88° F., with a mean of 62°, from 10 to 14 days is the normal length of the period.

LARVAL PERIOD.

When the egg is placed in the germ or in the starch of the kernel the young grub, breaking through the bottom of the shell, finds a plentiful supply of food. Development of the grub is most rapid when it is located in the germ. Progress is a little slower in the seft starch, while development in the tough horny endosperm is very slow and the larval period is greatly prolonged.

NUMBER OF LARVAL STAGES.

There are three larval stages. The first two are about equal in length, while the third is slightly longer. Table 3 gives data showing the variation in the length of these stages at different times of the year

TABLE 3.—*Life history data of Caulophilus latinasus.*

No.	Date egg was laid.	Date egg was hatched.	Length of egg stage.	Date of first molt.	Length of first larval stage.	Date of second molt.	Length of second larval stage.	Prepupal form.	Length of third larval stage.	Date pupated.	Length of pre-pupal stage.	Adult emerged.	Length of pupal stage.	Period from egg to adult.	Temperature for period of development.		
															Maximum.	Minimum.	Mean.
			Days.		*Days.*		*Days.*		*Days.*		*Days.*		*Days.*	*Days.*	° *F.*	° *F.*	° *F.*
1	Aug. 1	Aug. 5	4	Aug. 11	6	Aug. 17	6	Aug. 22	5	Aug. 23	1	Aug. 28	5	27	94	71	82.5
2	8	12	4	18	6	22	4	30	8	31	1	Sept. 5	5	28	94	69	81.5
3	10	14	4	19	5	22	3	29	7	30	1	4	5	25	94	69	81.5
4	11	15	4	20	5	26	6	Sept. 1	6	Sept. 2	1	7	5	27	94	69	81.5
5	13	17	4	22	5	27	5	1	5	2	1	7	5	25	94	69	81.5
6	Mar. 25	Mar. 30	5	Apr. 7	8	Apr. 13	6	Apr. 26	13	Apr. 27	1	May 2	5	38	86	61	73.5
7	28	Apr. 2	5	10	8	17	7	27	10	28	1	4	6	37	86	61	73.5
8	June 30	July 6	6	July 12	6	July 17	5	July 31	14	Aug. 1	1	Aug. 6	5	37	92.5	70	81
9	July 1	5	4	12	7	17	5	23	6	July 24	1	July 29	5	28	93	70	81.5
10	1	5	4	12	7	16	4	27	11	28	1	Aug. 2	5	32	93	70	81.5
11	10	14	4	0	6	25	5	Aug. 8	14	Aug. 9	1	July 14	5	35	92	70	81
12	11	15	4	1	6	26	5	3	8	4	1	9	5	29	92	70	81
13	Nov. 11	Nov. 18	7	Dec. 2	14	Dec. 19	17	Dec. 30	11	Jan. 1	2	Jan. 14	13	64	76	51	63.5
14	16	24	8	5	11	20	15	Jan. 5	16	7	2	20	13	65	76	49	62.5
15	22	Dec. 2	10	12	10	27	15	11	15	13	2	Feb. 9	27	79	76	50	63
16	Dec. 6	20	14	Jan. 3	14	Jan. 13	10	Feb. 3	21	Feb. 5	2	20	15	76	76	50.5	63
17	13	27	14	10	14	26	16	14	19	15	1	26	11	75	75	50	62.5
18	22	Jan. 2	11	14	12	27	13	11	15	12	1	24	12	64	76	51	63.5
19	Jan. 4	14	10	27	13	Feb. 8	12	22	14	24	2	Mar. 8	12	63	76	51	63.5

LARVAL HABITS.

The larva or grub bores straight down into the grain at first and is rarely found near the surface. It tunnels around rather aimlessly, filling up the passageway behind it with frass and borings. It usually remains in the soft parts of the grain.

PREPUPAL STAGE.

When fully grown the larva prepares for the change to the pupa or resting stage. It uses the end of its burrow for a pupal chamber, packing the frass and borings at the ends into a compact mass.

The larva lengthens out and becomes sluggish, assuming the prepupal form. This stage lasts for one day in warm weather and two days in winter.

PUPAL STAGE.

The pupal stage lasts for a period of five days during warm weather when the temperature ranges from 65° to 99° F., with a mean of about 81°. As with the other stages, cold weather has the effect of lengthening the period. Table 3 contains data showing the varying length of this stage at different times of the year.

NUMBER OF MALES AND FEMALES.

Of several hundred weevils reared in the laboratory and of large numbers collected in the field, the males and females were about equal in numbers. The males and females closely resemble each other in outward appearance and can not be differentiated without the aid of a magnifying glass.

As with many other weevils the beak of the female differs slightly from that of the male and affords a ready means of distinguishing between the two sexes. The beak or proboscis of the female is approximately equal in width for its entire length and is longer and more slender than that of the male. The beak of the male is slightly enlarged at the tip and narrows gradually toward the base.

COPULATION.

Copulation occurs within a few days after emergence and is repeated at intervals. It occurs chiefly at night. These weevils are rarely to be seen in copula during the day.

Unfertilized females have been observed to lay eggs but rarely. None of these eggs have been found to hatch, so it is doubtful whether unfertilized females are capable of laying fertile eggs.

LIFE CYCLE.

The period from egg to adult during warm weather averages about 30 days, which with an average preoviposition period of 22 days gives

an average life cycle of 52 days. This is 18 days longer than the shortest record obtained and considerably shorter than the life cycle during the winter months.

LONGEVITY.

The average length of life of the adult weevil is about 152 days when reared in captivity. Of fertilized females one lived for 209 days while two unfertilized females lived for 240 and 244 days, respectively.

When deprived of food these weevils are capable of living for extended periods if the temperature is not too high. Fifty weevils were placed without food in a chamber with a constant temperature of 60° F. The majority lived for a period of 55 days, while a few survived for 90 days and one for 96 days. During normally warm weather these weevils will live for from 5 to 12 days without food.

PARASITES.

The larvæ of this weevil are attacked by three hymenopterous parasites, *Cercocephala elegans* Westwood, *Aplastomorpha vandinei* Tucker, and *Zatropis* sp.

Larvæ, pupæ, and eggs are all attacked by a predacious mite, *Pediculoides ventricosus* Newport.

CONTROL MEASURES.

This weevil may be effectively controlled by the standard remedies advocated for the control of insect pests of stored grain.

TECHNICAL DESCRIPTION OF IMMATURE STAGES.

EGG.

Egg opaque, shiny white, bottom broadly rounded, top flattened and fitting into a translucent cap. Length, without cap, 0.45 to 0.47 mm.; width, 0.27 to 0.32 mm.

LARVA.

Mature larva 2 to 2.5 mm. in length, a white, footless, fleshy grub, with body curved and wrinkled. Head light brown or straw color, the anterior margin and mandibles a darker brown. Head about as broad as long, almost circular in form. Epicranial and frontal sutures distinct and light in color. There are also two oblique, longitudinal, light stripes rising from the frontal sutures and coalescing with the epicranial suture near the base of the head. Frons subtriangular, with a distinct dark median line running from posterior angle to middle, and indicating carina. Frons provided with four pairs of large setæ, sutural margins each bearing one seta. Epicranial lobes bearing the following setæ: One close to posterior angle of frons and located in the oblique, longitudinal stripe rising from the frontal suture, one small seta posterior to this and near occiput, two anterior to it on disk of epicranium, two opposite middle of frons, one opposite middle of mandible, one opposite hypostomal angle of mandible and one on hypostoma near base of mandible. Epistoma represented by thickened anterior margin of the front. Pleurostoma represented by somewhat darker declivous

area surrounding the mandibular foramen. Mandibles stout, triangular, with the apex produced into an acute apical tooth. Inner edge toward apex provided with a subapical tooth and a small medial tooth, no molar structure. Dorsal area of each mandible armed with a pair of stout bristles set close together. Eye represented by a well-defined black spot beneath the exoskeleton. Clypeus broad at base, sides narrowing towards apical angles; distinctly broader but not as long as labrum. Epistomal margin provided with two fine hairs on each side. Labrum about as broad as long, rounded in front, provided with three pairs of large setæ and five pairs of short, thickened, marginal setæ.

Maxillæ terminated by a 2-jointed palpus and setose maxillary lobe. Maxillæ each provided with four setæ as follows: One on first segment of palpus, two on vaginant membrane between palpus and palpifer, and one stouter and larger midway between palpus and cardo. The stipes labii enforced posteriorly by a median triangular chitinization bear 2-jointed palpi and a single pair of setæ. Ligula bearing four small setæ. Mentum and submentum fused and bearing three large setæ on each side. Pronotum simple and undivided. Præscutal and scuto-scutellar areas roughly indicated by rows of setæ. Mesothoracic and metathoracic segments divided above into two areas representing præscutum and scuto-scutellum; below and adjacent to epipleurum is the alar area. Below ventro-lateral suture are a well-defined hypopleurum, coxal lobe, and eusternum. The thoracic spiracle, located on the pre-epipleural lobe of the mesothorax, is bifore, with the fingerlike air tubes pointing dorsad, and is somewhat larger than the abdominal spiracles. Ten abdominal segments, ninth small, tenth reduced. Each tergum of first eight abdominal segments divided above into three distinct areas—praescutum, scutum, and scutellum. Below and adjacent to epipleurum is the alar area. Below ventro-lateral suture are a well-defined hypopleurum, coxal lobe, and eusternum. Abdominal segments provided with setæ as follows: Two on præscutum, five on scutellum, two on alar area, two on epipleurum, one on coxal lobe, and two on eusternum. Each of the first eight abdominal segments bears a bifore spiracle, that of the eighth being slightly larger than the rest.

Stage.	Width of larval head.
1	0.22 to 0.23 mm.
2	.33 to .38 mm.
3	.53 to .57 mm.

PUPA.

Pupa white when first transformed. Length, 2.8 to 3 mm.; width, about 1.3 mm. Tips of elytra attaining the sixth abdominal segment, tips of metathoracic tarsi not extending beyond wing tips. Head rounded, beak short and broad. Head provided with two prominent spines toward the vertex, two smaller ones on sides above eyes, a spine on each side of front between eyes, two pairs on beak between frontal ones and base of antennæ, two pairs on beak between base of antennæ and tip of beak, and four pairs of small setæ on tip of beak. Prothorax provided with two pairs of antero-marginal setigerous tubercles, one pair of antero-lateral, two pairs of postero-lateral, and four pairs of dorsal setigerous tubercles. Mesonotum and metanotum each provided with two pairs of spines. Abdomen with eight distinct dorsal tergites; dorsal area of each armed with two pairs of large spines; lateral area of each tergite armed with a spine at base of which is a small seta. Epipleural lobes each obscurely armed with one or two minute setæ. Ninth segment armed as usual with two prominent pleural spines.

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